was a general deficiency, ranging from 0.2 to 0.92 over central and east Texas, and from 0.26 to 1.40 over north Texas, with the greatest in the vicinity of Paris. The greatest monthly precipitation was 7.23 at Stafford.

Utah.—The mean temperature was 72.0°, or about 1.0° below normal; the highest was 111°, at St. George on the 11th, and the lowest, 33°, at Soldier Summit on the 1st. The average precipitation was 1.81; the greatest monthly amount, 3.85, occurred at Koosharem, and the least, 0.12, at Cisco.

Virginia.—The mean temperature was 76.3°, or about normal; the highest was 102°, at Bonair on the 28th, and the lowest, 42°, at Blacksburg on the 8th. The average precipitation was 6.99, or 3.38 above normal; the greatest monthly amount, 11.23, occurred at Spottsville, and the least, 3.35, at Birdsnest.

Washington.—The mean temperature was 68.2°, or 3.3° above normal; the highest was 112°, at Bridgeport, Fort Simcoe, and Connell, and the lowest, 37°, at Blaine on the 29th, and Hunters on the 22d. The average precipitation was 0.06, or 0.50 below normal; the greatest monthly amount, 0.60, occurred at Rosalia; no rain fell at more than half of the stations. The chief characteristic of the month of July, 1896, was the general absence of precipitation. Seldom, if ever, has there been such a protracted drought in the eastern section, and in the western section there has been but one like it since the settlement of the country; that was in 1883. This year, at 80 per cent of the stations no rain at all fell, or only the slightest trace. The drought begun in June, there having been scarcely any rain after the 9th. In the eastern section of the State there were a few scattered thunderstorms during the month of July.

West Virginia.—The mean temperature was 73.2°, or about 2.0° below normal; the highest was 97°, at Hewett on the 29th, and the lowest, 46°, at Beckly on the 10th, and Bloomery on the 18th. The average rainfall was 9.07, or nearly 5.0 above normal; the greatest monthly amounts were 15.70, at Phillippi; 15.60, at Beverly; 15.15, at Weston, and 15.09, at New Martinsville. The least amount was 2.91 at Green Sulphur Springs. Exceedingly heavy rains occurred in the northern-central and Ohio Valley counties, and in other sections the rainfall was considerably above the normal. The rivers of the northern part of the State were flooded to a height greater than ever before known at this period of the year, and very great damage was done to crops and property along their courses and on lowlands. In many localities the crops were totally destroyed, and in all sections were more or less injured by the wet weather. These storms were generally electrical, and in some cases exhibited tornadic tendencies. The observer at Beverly reports the occurrence, on the 24th, of the most disastrous storm that ever visited that valley, and at Glenville, on the 30th, a storm occurred which was said to have been the severest ever known in that locality, and which exhibited the character of a tornado. The heaviest of these storms occurred from the 13th to 16th, the 21st to 25th, and on the 28th and 30th.

Wisconsin.—The mean temperature was 69.8°, or less than 1.0° below normal; the highest was 100°, at Medford on the 3d and Osceola Mills on the 12th, and the lowest, 34°, at Antigo on the 16th. The average precipitation was 3.15, or slightly less than normal; the greatest monthly amount, 8.30, occurred at Delevan, and the least, 0.7, at Pepin.

Wyoming.—The mean temperature was 68.0°, or about normal; the highest was 102°, at Lusk on the 13th, and the lowest, 32°, at Wheatland on the 14th. The average precipitation was 2.04, being decidedly above normal; the greatest monthly amount, 6.35, occurred at Cheyenne, and the least, 0.52, at Wheatland.

SPECIAL CONTRIBUTIONS.

KITES IN MONTANA.

By Mr. A. B. COE.

From recent letters received from Mr. R. M. Crawford, director of the Montana section of the Climate and Crop Service, and from Mr. A. B. Coe, voluntary observer at Kipp, Montana (N. 48° 45′, W. 112° 45′, elevation about 4,000 feet), we take the following notes, and hope that others may be led to pursue similar studies with the same enthusiasm. Mr. Coe says:

I herewith transmit an account of a little experiment tried recently, employing a cellular kite of the dimensions described in the November, 1895, WEATHER REVIEW for the purpose, and my maximum thermometer.

A phase of our climate at this station is the frequent veering of the wind from westerly points to north or northeast, accompanied by an extremely rapid fall of temperature, and usually more or less precipitation.

I have often thought that these cold waves did not reach very high up, and that at no great height above them the warm southwest wind still prevailed. For several days prior to July 29, 1896, my maximum had been climbing up into the nineties too frequently for comfort. The air was dense with smoke, when the wind suddenly veered to the northeast, blowing steadily at about 15 or 20 miles an hour, and pretty thoroughly clearing the atmosphere of smoke. The temperature fell 51° in the next twenty-four hours, and on the 21st the clouds were dragging on the ground, and precipitating both rain and snow. At 11.30 a. m., on that date, my minimum thermometer registered 32°, but only for about twenty minutes, when it rose to 38°. From occasional glimpses of the sun obtained through breaks in the clouds, and from its red appearance, it was evident that there was another current of air full of smoke at a low altitude, blowing from the west, and undisturbed by the cold wave from the northeast beneath it.

The time and circumstances seemed propitious to test my theory, so I climbed to the top of a hill near my home, which I found by triangulation to be about 200 feet above my usual place of observation. Thither I bore my tailless kite, maximum thermometer, and 4,800 feet of No. 24 twine, tagged at every 100 feet for convenience in computing elevation. I secured the thermometer firmly in a pasteboard tube, open at both ends, and fastened this to my kite with wire. At 1.15 p. m. the surface temperature was 38°, when with the help of an assistant I soon had both kite and instrument mounting steadily upward on a flight of exploration.

I will have to add right here, that my kite is a "stayer," and the only one of any description I ever made that would fly. I let it run out 1,000 feet, and on drawing it in found that there was no difference in its registration. Again I let it out, and it was not until 3,900 feet of twine had unreeled that any change in its action was observed; then I noticed that the kite above the fog and clouds was pulling nearly northeast, instead of southwest, as at first. Upon pulling it in, during which operation it again assumed its strain to the southwest, I was overjoyed to discover that the register stood at 77°, while at the point where I stood it remained at 39°. Being anxious to make sure that there was no mistake, I sent the instrument up again, and obtained a like result at about the same altitude, the kite going through the same movements as at first; but whether my observation is of any value aside from the personal satisfaction derived, is a question.

I anticipate some interesting experiments this coming winter in this direction, to determine, if possible, at what elevation the warm winds locally termed "chinooks" blow, at times when their influence is felt many miles east of this point, while remaining intensely cold here.

In response to a request for further data as to the protection of his thermometer and other matters, Mr. Coe writes:

I employed a strong pasteboard tube 12 inches in length, and 1¼ inch in diameter for the purpose. In this I sewed my maximum thermometer securely with strong pack thread, and packed fine cotton around each end for the better protection of the tube. Directly over the tube I cut a slit ¼ by 8 inches, so that the scale could be readily seen without removing the instrument. Four feet from the belly band I secured the tube to the twine with fine wire. The wind was blowing a good stiff breeze at the time, probably 20 miles an hour, and from the time the kite was let go until pulled in 23 and 25 minutes, respectively, elapsed, and the difference in temperature at each trial was the same as stated. My kite rose and descended very steadily without diving or pitching, so that I could not well believe that the difference in temperature was caused by any condition other than an upper current of warm air, blowing from the southwest at that altitude. The clouds near the earth were very dense, while from another experiment tried at the same time, I am satisfied that the kite passed through the clouds into bright sunshine. I secured a strip of sensitized paper between two thin pieces of mica, and sent it up attached to the kite, and exposed a similar piece to the light on the ground, in a like manner to protect the paper from dampness. While the paper at my feet remained unchanged in color to any extent the piece sent up was changed to a bronze black.

SUNSHINE AT THE SOUTHERN CALIFORNIA AGRICULTURAL EXPERIMENT FARM, NEAR POMONA, CAL.

By Mr. A. J. HENRY.

The percentages of sunshine for the six months, January to June, 1896, at the Southern California Agricultural Experiment Farm are given in the table below. The data are published as compiled in the Records Division of the Weather Bureau, from the original photographic sheets made under the direction of Mr. J. W. Mills, foreman of the experiment station, and furnished to the Weather Bureau through the courtesy of Prof. E. W. Hilgard, director, Berkeley, Cal. No corrections have been applied to the records. Pomona, Cal., is in latitude N. 34° 3′.

Hourly percentages of possible sunshine near Pomona, Cal.

Month.	Percentages of possible sunshine recorded during the (local mean time) hours ending—														Hours of sunshine.		
	A. M.							P. M.									
	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	Total actual observed.	Total possible.	Percentage of possible.
1896.															H'rs.	H'rs.	
January	....	....	20	49	56	66	66	56	69	70	71	36	....	....	176.0	316.2	56
February	....	4	52	73	86	90	89	87	88	88	88	74	11	....	238.6	318.5	75
March	....	16	53	65	73	76	77	72	68	70	67	62	22	....	222.9	372.3	60
April	6	51	67	69	80	77	84	81	76	80	84	85	69	7	273.3	391.6	70
May	3	46	68	78	82	90	85	81	84	85	83	85	79	10	297.1	432.6	69
June	7	33	43	62	74	81	87	94	96	96	99	96	93	30	296.7	431.5	76

KITE EXPERIMENTS AT THE WEATHER BUREAU.

By C. F. Marvin, Professor of Meteorology, U. S. Weather Bureau.

[Continued from the June Review.]

EFFICIENCY.

Hitherto no exact and scientific methods appear to have been employed to determine the relative merits of different kites, or to fully measure and analyze their action. Experimenters in general have been contented to make a rough estimate by eye of the angular elevation attained, or if this has been measured the results, with rare exceptions, have been inaccurate, and the observations limited to a very small number. Often, probably, but a single reading has been made at a favorable moment when the kite had momentarily attained an extreme elevation. Moreover, the observations have generally been made with the object of ascertaining the altitude of the kite when a long length of deeply sagging line was out. Little or no notice appears to have been given to the effect of the long line in modifying the angular elevation of the kite. If any accurate measurements of the behavior of kites have been systematically made such measurements have, with one or two exceptions, been conspicuously absent from any published accounts of kite experiments known to the writer. It is therefore impossible to form any estimate of the relative merits of the kites employed by different individuals. Eye observations without the aid of instruments suffice to determine only general qualities of steadiness, etc. Those factors upon which the usefulness of a kite for meteorological purposes depends, namely, the *lift* and *drift*, can be determined accurately only by aid of instrumental measurements. Eye estimates of the angular elevation of kites tend nearly always to exaggerate the amount of the angle, and data of this sort respecting the behavior of kites can have no place in scientific investigations.

Various methods of expressing numerically the merit of a given kite may be employed. The *lift* and *drift* may be made the measure of excellence of a given kite. But the *lift* and *drift* of a kite vary with every gust of wind, and it is difficult to deduce from these quantities a true numerical rating of the merit of a kite under examination. This objection to the use of lift and drift as a measure of excellence would have less weight if the wind blew with a steady direction and constant force, but this is never the case. Moreover the *lift* and *drift*, aside from depending directly upon the force of the wind, depend further upon both the actual surface of the kite and upon the angle of incidence. A very perfect kite which happened to be bridled in such a fashion that the angle of incidence was, for example, 25°, would, in all probability, show a smaller lift and a larger drift than a much inferior kite bridled so that its incidence was 15°. This difference of incidence would, in all probability, wholly escape the notice of an ordinary observer unless his attention was specifically directed to discover it. Even if discerned with the eye the real numerical relation could be established only by carefully made instrumental observations. The *lift* and *drift* in themselves, therefore, do not constitute a suitable basis for a true numerical estimate of the useful effect available in a kite. They are in fact only conventional and derived ideas. We must go back of them to the fundamental forces from which they are derived for the basis upon which true comparisons can be made. *Efficiency* is the technical term widely employed in all branches of engineering to designate numerically the useful effect available in machines of any sort. Thus, we have the efficiency of a steam engine, of a boiler or furnace, the efficiency of electric generators, motors, converters, etc., so likewise we may have the efficiency of kites. This measure of merit, as adopted at the Weather Bureau for the comparison of kites with each other, is based upon fundamental mechanical principles, and is widely applicable to any kind of kite. The resulting measure is not directly dependent upon the angle of incidence of the kite or upon the direction or force of the wind.

Efficiency of kites.—The basis upon which any rating of efficiency is deduced is very largely a matter of choice. In dealing with machines and appliances for producing physical or mechanical effects, economical considerations have much to do with the ultimate or absolute utility of the devices employed. From the economic standpoint an efficiency rating is an exceedingly complex result, depending upon many factors of the most heterogenous character — cost of space, wages of employees, cost of transportation, interest on investment, etc. These factors can be related to each other only in a highly arbitrary and empirical manner. The efficiency of mechanical devices, as the term is ordinarily used, is not generally deduced upon the economical basis but depends upon purely mechanical and physical considerations of cause and effect. Dismissing economics we will likewise define the efficiency of kites upon the physical and mechanical basis. Even here, choice may be made among several methods. We may consider that the most efficient kite is one which can attain the highest elevation. As we shall see hereafter, the elevation attained by a kite is purely a question of the forces acting upon the string. It is very plain that to make the efficiency of a kite depend in any way upon the string is not desirable. Even if we eliminate, as we may, effects due wholly to the string, and make the efficiency of the kite depend upon its power to attain elevation, we still make a bad choice, for we would thereby fail to consider that kites may be employed for other purposes than attaining elevations. A highly efficient kite from such a standpoint would be highly inefficient if it were employed to pull sleds or carry a line ashore from a stranded vessel.

A basis upon which the efficiency of a kite can be deduced, that is not open to such objections as raised above, may be had by considering only the *inclination of the total resultant wind pressure* to the surface of the kite. A kite, fundamentally, is a surface either plane or curved against which it is designed the wind shall press. The ideal kite is that surface; the actual kite is a material substance having thickness, edges, possibly a tail, etc. The string is an entirely separate accessory not necessarily included in discussing efficiency. In the analysis of the action of the wind upon surfaces a principle of efficient action was pointed out on page 162,[1] as follows: "*The condition of ideal efficiency (that is, an efficiency of 100 per cent), in the action of the wind upon thin plane surfaces, obtains when the total resultant pressure is exactly normal to the surface.*" Recognizing that a kite is a surface against which the wind shall press, we say broadly that the pressure is most efficiently exerted when for plane surfaces the total pressure is exactly normal to the surface. For arched sur-

[1] Monthly Weather Review, May, 1896.